Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date:9/17/2014 Scale: 1:300,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.*

FIGURE 4.3-1
FEIS WINTER ROAD (PREFERRED OPTION)

ENVIRONMENTAL IMAPACT STATEMENT
APPENDIX 2K

KIGGAVIK PROJECT

AREVA

File: Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 2 - Project Description\Volume 2 - Tier 3\Appendix 2K - Winter Road Report\MXD\Figure 4.2-1 FEIS Winter Road.mxd

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4.3.1 Removal of the North Winter Road Option

During the spring 2013 pre-hearing conference, a commitment was made to only include one winter road option in the FEIS. There were concerns about the approval of multiple road options, when only one option was required at the start and only one winter road was planned to be built. To confirm that the winter road south route was preferred over the winter road north route, a comparison was completed for the two options. The comparison is presented in Table 4.2-1 below. A more detailed comparison is provided in Technical Appendix 2A – Alternatives Assessment.

Table 4.3-1 Comparison of Winter Road Options

Item	South Winter Road	North Winter Road
Community Preference	There is no strong community preference between the north and south winter road	
Distance	41km over land 57km over water	40km over land 82km over water
Road Complexity	Less complex	More complex
Difficulty of Engineering	Less difficult	More difficult
Crossing of Thelon River Required	No	Yes
Overall Cost	Lower	Higher
Decommissioning	Due to the roads being winter roads, decommissioning requirements would be similar	

Although one comment was received showing a preference for the south winter road (EN-BL CLARC Apr 2013[27]), there was no general community consensus on one winter road compared to the other. Based on the comparison, and results of the alternatives assessment, it was clear that the south winter road was the preferred road. The south winter road is retained as the preferred option, and the north winter road removed from the EIS. The south winter road was chosen over the north winter road due to its shorter distance, elimination of the need to cross the Thelon River, and lower cost.

[27] EN-BL CLARC Apr 2013: *Committee members stated they felt the southern winter road was more direct (fewer turns) and therefore appeared to be a better option. Committee member pointed out that there are more graves and areas of significance to Inuit on the northern part of the winter road*.

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Attachment A EBA Winter Road Report

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ISSUED FOR USE

KIGGAVIK PROJECT
WINTER ROAD REPORT

V33101016

October 2010

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1066 West Hastings Street • Vancouver, British Columbia V6E 3X2 • CANADA

TABLE OF CONTENTS

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APPENDICES

1.0 INTRODUCTION

The Winter Road Report is one of a group of studies performed by EBA of various aspects related to access and infrastructure for the proposed Kiggavik Mine Project. The other studies include:

- Northern and Southern All Season Road Report
- Physical Environment Within the DEIS Report
- Haul Road Report
- Port Facility Report
- Mine Site Airstrip Report
- Andrew Lake Dyke Report
- Mine Site Building Foundations Report

Figure 1.0-1 below shows the general location of the Kiggavik Project.

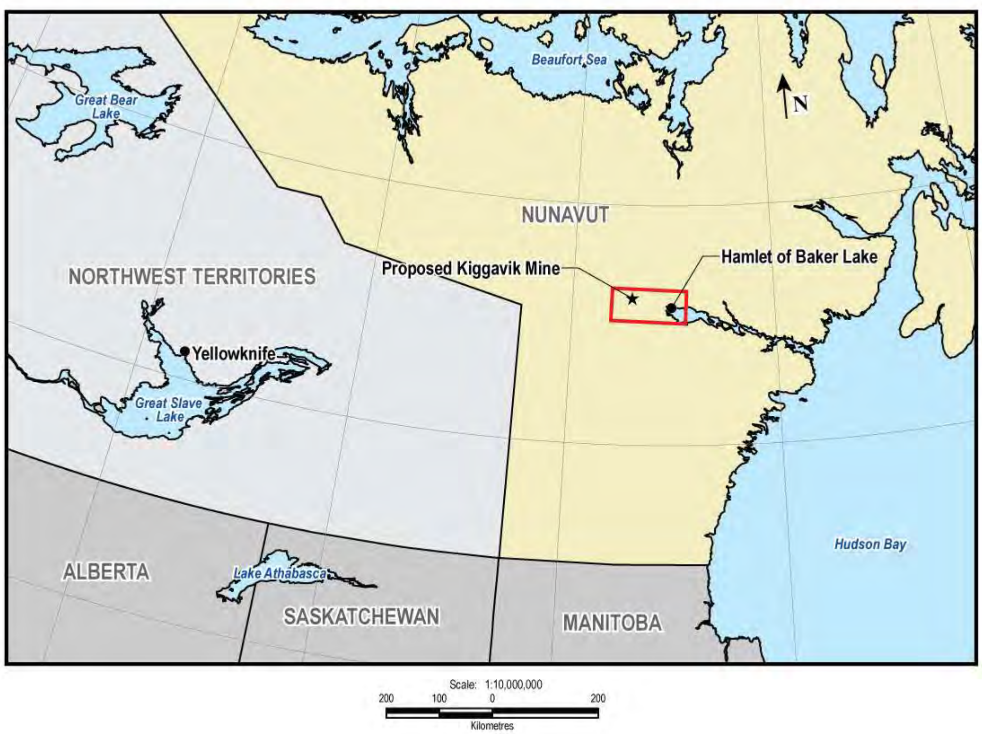
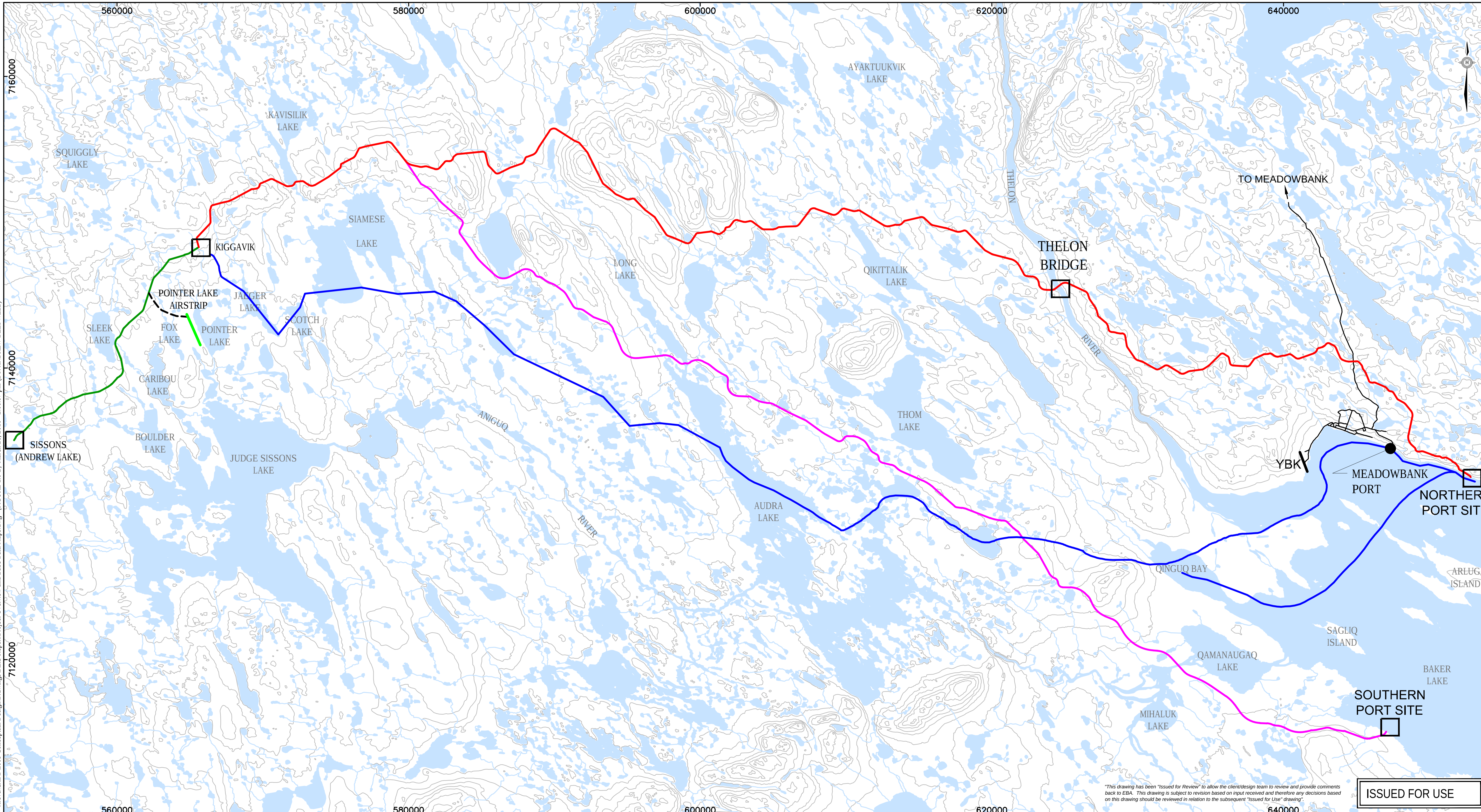


Figure 1.0-1 Key Plan

Figure 1.0-2 on the following page shows the various project elements discussed within this Report and the other Reports listed above.



PROPOSED

- Northern All Season Road
- Southern All Season Road
- Haul Road
- Winter Road
- Pointer Lake Airstrip

EXISTING

- Roads
- 20m Contour - NTS Base Data
- YBK Airport

SCALE 1:250,000

2 0 2 6 10km

PROJECTION: UTM Zone 14

DATUM: NAD 83

CLIENT

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KIGGAVIK PROJECT
CIVIL INFRASTRUCTURE REPORT

PROJECT OVERVIEW MAP

PROJECT NO.	DWN	CKD	REV
V33101016	AJD	DCD	-
OFFICE	DATE		
VANC	March 26, 2010		

Figure 1.0-2

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Project Overview and Base Data Maps.dwg [FIGURE 1.0-2] March 26, 2010 - 2:00:07 pm (BY: ANDREW DEEPWELL)

2.0 WINTER ROAD

2.1.1 General

Two potential routes for a winter road with minor alternative segments are shown on Figure 2.1-1. These routes should be considered corridors within which the actual routing could be established within about one kilometre of the indicated line. These alternative routes have been selected following a process that included consideration of many variables and examination of several options. The two alternatives shown are considered the best options for either a northern route or a southern route. The northern route crosses the Thelon River approx. 25 km upstream of its estuary in order to tie into the existing Meadowbank Road north of the community. The southern alternative follows a chain of lakes south of the River and crosses Baker Lake ice outside of the Thelon estuary far enough south-east of the community to maintain a 1 to 2 km buffer. Both routes are feasible alternatives with the southern route identified as the shortest and most effective for a variety of reasons that are described in this Section.

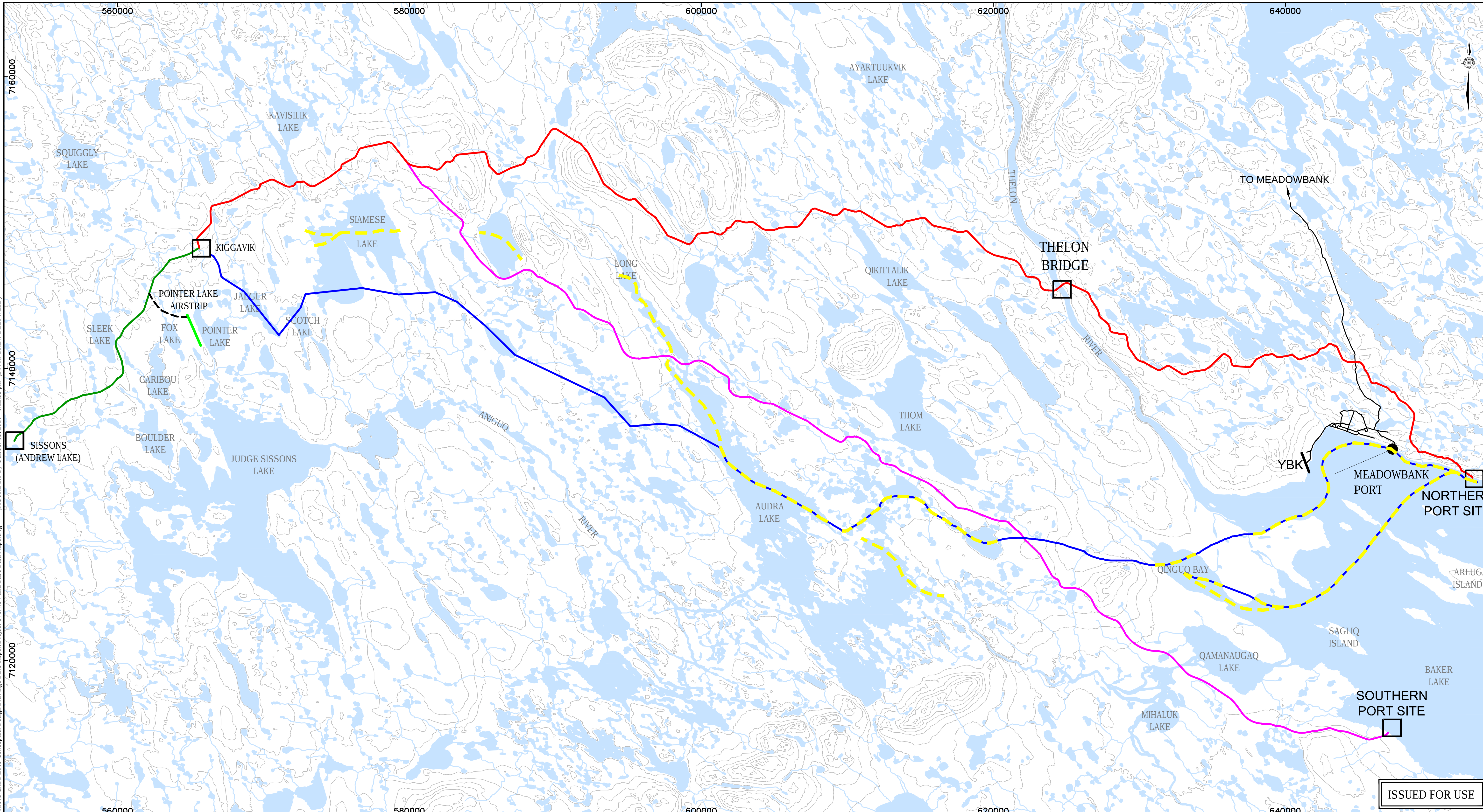
The effective use and duration of a winter road depends on a number of variables, the most important of which are the climatic conditions (air temperatures and snowfall), surface conditions, and the amount and type of traffic that will be using it.

Winter roads can be constructed over land and/or over ice. Overland crossings rely on a frozen subgrade to support the vehicle loads and a prepared surface layer to provide a level driving surface. Surface layers usually consist of compacted snow and/or ice where available. Compacted snow roads are typically used for transporting exploratory equipment or personnel on tracked vehicles to remote areas on a daily basis. Ice capped snow roads are constructed for highway legal loads, such as B-trains and Super B-trains, with a higher frequency (over 30 loads per day). A discontinuous pad of granular fill may be required over rough terrain or where there is insufficient snow cover to create a smooth surface.

Over-ice crossings consist of either floating ice or ground-fast ice (ice frozen to the lake bottom). Floating ice supports vehicle loads through buoyancy and the flexural strength of the ice. Ground-fast ice has additional bearing capacity due to the sub-grade supporting the overlying ice cover. A stable ice surface is the preferred winter road routing for regions of cold continuous permafrost. The roads can be opened early by effective snow removal, and surface preparation is minimal. Nuna Logistics, who participated in route optimization studies, apply the 10 to 1 rule of thumb when assessing routing alternatives. They have found that 10 km of winter road over lake ice can be opened and prepared for travel with the same effort as one km over land. If the effort equates to the cost then there is a substantial benefit to following long lakes, a factor in support of the south route.

2.1.2 Areva's Functional Requirements for the Winter Road Option

The primary winter road traffic will be annual resupply of fuel and mine operational goods such as explosives and machinery. Concentrate in the form of yellowcake will be removed predominantly by aircraft, but some may be trucked to the dock in containers for barge shipment. The Project Description report provided the functional requirements that are



PROPOSED

- Northern All Season Road
- Southern All Season Road
- Haul Road
- Winter Road
- Pointer Lake Airstrip

EXISTING

- Roads
- 20m Contour - NTS Base Data
- YBK Airport
- Winter Road Geophysics Survey

SCALE 1:250,000

2 0 2 6 10km

PROJECTION: UTM Zone 14
DATUM: NAD 83

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CIVIL INFRASTRUCTURE REPORT

WINTER ROAD
GEOPHYSICS SURVEY TRACKS

PROJECT NO.	DWN	CKD	REV	
V33101016	DCD	GEW	-	Figure 2.1-1
OFFICE	DATE			
VANC	March 26, 2010			

Q:\Vancouver\Transportation\V331\Projects\V33101016 - Areva\CADD\2009 Conceptual Design\Drawings\DEIS Report\Project Overview and Base Data Maps.dwg [FIGURE 2.1-1] October 05, 2010 - 6:12:55 pm (BY: ANDREW DEEPWELL) summarized in the following table. EBA estimated an average winter road operating window of 90 days giving an average traffic volume of 43 round trips per day (28 trips per day for dry goods and 15 trips per day for fuel).

EBA's analysis indicates that with appropriate storage facilities at each end of the road, either winter road option would easily meet the needs of the project. This assessment has been based on precedence from other industrial winter roads that show that average daily loaded trips in excess of 150 are achievable using standard highway vehicles such as super B-train trucks. The vehicles used on this road would be dedicated to the annual winter resupply and could be custom designed and built to suit the operation. Greater payloads per trip would be readily achievable by adding axels or lengthening trailers to manage the stress imparted to floating ice.

TABLE 2.1-1: AREVA'S ANNUAL FUNCTIONAL REQUIREMENTS FOR THE WINTER ROAD OPTION

Requirements	Parameter
Dry Goods	81,000 tonnes
B-train truck loads (7 axle, 56.5 metric tons GVW)	2550 loaded trips/season
Average payload	32 tonnes
Fuel	70,000,000 litres/season
Super B-train truck loads (8 axle, 63.5 metric tons GVW)	1370
Average payload	43 metric tons (51,000 litres)

2.1.3 Base Data and Field Reconnaissance

The base data used to determine the suitability and location for the winter road includes the following:

- Air photo interpretation, both from the 2007 Pre-Feasibility Report and the airphoto evaluation work;
- Helicopter overview flight in summer of 2008;
- Winter geophysical survey for ice thickness and bathymetry, April 2009;
- Two days of helicopter overflight together with personnel from Nuna Logistics and PEL Expediting Ltd (Baker Lake) in June 2010;
- Meeting with three Baker Lake elders on June 3, 2010 for discussion and to obtain advice on sensitivities with respect to crossing the Thelon River and road interaction with Baker Lake community infrastructure.

2.1.4 GPR, Bathymetric and Ice Thickness Information

A ground-penetrating radar (GPR) survey was conducted over the course of seven (7) days, from April 23 to April 29, 2009. A Mala Geosciences Ramac CUII GPR unit with 50MHz rough-terrain antenna was used to profile lake bathymetry along the proposed winter road routes. James Mickle, from EBA's Calgary office, navigated the proposed routes on snowmobile by following a series of tracks programmed into a handheld GPS. All electronics, including data collection laptop, differential GPS unit (DGPS) and GPR control unit, were secured to the back of a komatik in a plastic action packer, and this sled was pulled behind another snowmobile by a local helper, who followed the lead snowmobile. The radar antenna was dragged along the entire route behind the komatik. The system was set to acquire approximately 10 radar traces per second, while survey speed was typically 5 to 10km/h. Thus, at this speed, lake depth and relatively coarse ice thickness information was acquired at horizontal intervals of approximately 14 to 28 cm.

Field conditions at the time of the survey were generally cold and windy, often with poor visibility. The exact edges of the lakes were not usually obvious. Snow cover on the lake surfaces consisted, in general, of rather hard, bumpy snow dunes ranging in thickness from 30 to 70cm. Bare ice was rarely encountered on the lakes. Analysis of the GPR data reveals that the lake ice ranged from approximately 1.5 to 2 m in thickness in most areas surveyed. The data and its assessment are included in Appendix A6.

2.1.5 Design Criteria

2.1.5.1 Over-Ice Crossings

Roads built over floating ice covers on lakes and rivers for B-trains and Super-B trains with a traffic volume consistent with Areva's functional requirements will need to be built to a 30m cleared width. This width is necessary to provide a 5m buffer along the edges separating the vehicle traffic from the thinner ice found under snow banks. It also provides additional lane width when roads are blown with drifted snow. Snow banks need to be managed carefully as they are an additional load on the ice, and the thinner ice underneath them is prone to cracking and flooding. It is often desirable in high wind locations to initially open the road to widths greater than the normal 30 m. This will provide space for the operational width to narrow throughout the season to a minimum width of 30 m.

Ice crossings for higher volume roads are usually built in the following sequence:

1. Pioneer the route by checking the thickness and quality of the ice with snowmobiles or amphibious vehicles such as the Swedish Hagglund;
2. Clear snow from the route to promote ice growth with equipment that meets the ice capacity requirements for initial ice thickness (e.g., sno-cats can be used to clear ice when it is 0.40 m thick);
3. Permit light traffic (2 axle trucks less than 5000 kg) on approved ice crossings with a minimum ice thickness of 0.35 m;
4. Clear snow to full 30 m width; this can be done with heavier snowplows once the ice reaches the minimum ice thickness (e.g, a 12,500 kg snowplow would need at least 0.5m of ice);

5. Clear alternate routes in areas where there could be pressure ridges that may block the route or where they can be used as express lanes for unloaded vehicles returning to Baker Lake;
6. Flood ice in areas where ice growth is lagging the natural growth and at locations where it is advantageous to ground the ice sheet;
7. Crossings can be opened to light haul traffic (3 axle trucks) and partially loaded B-train and Super B-train vehicles when the ice reaches a thickness of 0.75 m;
8. Crossings can be opened to fully loaded B-trains when the minimum ice thickness reaches 0.95 m and fully loaded Super B-trains when the minimum ice thickness is 1.05 m;
9. Check ice thickness during construction to determine when to change the load limits for the ice crossings and identify areas for flooding or monitoring.

During the operations of the ice crossings when they are opened to hauling traffic, rules should be observed to manage the risk of ice breakthrough. These rules are developed through an understanding of observing the ice characteristics during an operating season. Typical operating rules are as follows:

- Maximum vehicle speed for vehicles hauling at 100% of the load limit for the ice crossings: 25 km/h (e.g., a 100% loaded Super B on 1.05 m of ice);
- Maximum vehicle speed for vehicles at 50% of the maximum load limit of the ice crossings (e.g., an empty Super B on 1.05 m of ice): 35 km/h;
- Maximum vehicle speed for hauling vehicles that meet another hauling vehicle going in opposite direction: 10 km/h;
- Minimum spacing between vehicles hauling on the ice crossings: 500 m (no passing is allowed).

Other variables such as rapid changes in ambient temperatures, water depth, snow accumulation, traffic speed, monitoring efforts, safety considerations etc. have to be taken into account when operating over-ice crossings. The design of an ice road is a job for a professional who also prepares a project specific Ice Monitoring and Safety Plan (IMSP).

2.1.5.2 Over-Land Crossings

There are two options for building over-land crossings that can meet Areva's functional requirements:

1. Snow/ice pad over frozen subgrade;
2. A thin pad of granular material over frozen subgrade.

The typical practice in the NWT is to wait for the active layer to freeze to a depth, usually around 0.3 m, that will provide sufficient bearing capacity to support haul traffic. Adam (1978) found that for typical terrains, a freezing index of about 300 °C days was usually sufficient for the frost to penetrate to 0.3 m depth. A surface course is prepared by spreading and compacting a thin lift of snow or saturating the surface with water to create an ice capped snow road. The required snow surface course can vary significantly depending on the local micro-topography (e.g, presence of boulders and depressions) and sensitivity of the underlying tundra surface,

A granular surface pad is used in areas of rugged microtopography that would normally require levelling. Granular material should be well-drained, cohesionless soil, such as esker sand or gravel or quarried processed rock material that can be placed in winter. Granular pad thicknesses can range from a minimum of 100 mm up to 300 mm for levelling purposes. Like snow, a sufficient borrow source will need to be identified within a reasonable hauling distance of the over-land crossings.

Experience from the Tibbitt to Contwoyto Winter Road suggests that over-land portions of the winter road will evolve over several seasons as over-land crossing performance is reviewed. Sections typically start with compacted snow-ice surfaces but these are replaced with granular pads in areas that have shown to have poor performance in previous years. Eventually we could expect up to 50% of the over-land crossings consisting of granular fill pads.

Over-land roads that handle predominantly one-way traffic can be built to a 4 m width, with provision for the occasional pull-out for vehicles that are waiting for an opening in traffic. For two way traffic we would recommend a minimum width of 9-10 m. Routes will need to be chosen to keep grades less than 6% and provide sufficient horizontal curvature for traffic safety. Over-land vehicle speed limits can be set at 50 km/h where there are appropriate sight lines, grade, horizontal curvature and width. Provisions will need to be made to handle poor winter weather driving issues such as whiteouts, snow drifting/clearing, and surface traction.

Portages form the link between over-ice crossings and over-land crossings. Portage locations should be selected to minimize the disturbance of the tundra soil and its vegetation and provide grades that are acceptable to traffic. In some locations it may be advantageous to place granular material on the tundra to lessen the effort of maintaining the portage, particularly during the spring period.

On land, the road surface will either be a granular pad or an ice cap on compacted snow. The ice cap will typically be a thickness of 10 cm.

2.1.5.3 Regulatory Requirements

In Canada, the construction, operation and monitoring of winter roads are regulated by issuing Land Use Permits (LUP) in consultation with the appropriate Regional Land Use Inspector.

If there is a requirement to construct ice capped winter roads and portages, water needs to be withdrawn from lakes along the winter road routing. The Department of Fisheries and Oceans (DFO) has issued a Protocol, applicable in the Northwest Territories, which outlines guidelines for Winter Water Withdrawal during one ice-covered period. The same Protocol is applicable for Nunavut, as stated by DFO, Eastern Arctic Area. The Protocol stipulates:

a) In one ice-covered season, total water withdrawal from a single water source is not to exceed 10% (regulators have indicated that this figure could be reduced to 5%) of the available volume below the ice, provided the remaining water depth between the bottom of the ice cover and the lake bottom is =>1.50 m; and

b) The survey of the water body has to be conducted using an accurate continuous depth sounding methodology such as GPR. At least one longitudinal transect and perpendicular transects at a distance not greater than 500 m are required for volume calculations.

2.1.6 Design Overview and Related Issues

The winter road route would connect the Kiggavik Mine site to a port facility located east of the Hamlet of Baker Lake. The two potential routes selected from a number of alternatives are shown in Figure 2.1-1. The preferred route is the south alternative that utilizes the extensive ice surface provided by Audra Lake and crosses Baker Lake either on or just offshore of the recent deltaic deposits that form the Thelon estuary. The route would be approximately 103 km long with approximately 50% over frozen lakes and 50% over land but may vary somewhat depending on the route that would be selected during a detailed design. The road would head southeast from the port facility across Baker Lake and then travel in a general northwest direction over land and lakes toward the mine.

The topography is generally flat with the exception of a large rise of intrusive bedrock west of 20 km Lake and the large marine deposits just west of Baker Lake. The elevation of the route varies from a low of approximately 2 m above sea level at Baker Lake, to almost 200m at Kiggavik.

The majority of the overland portions of the route would be over till blankets and some till veneer with isolated portions over alluvial deposits in low areas which are often covered by thin organic layers. Between Long Lake (Audra Lake), large marine deposits and mixed till and marine sediments are dominant while there are alluvial (deltaic) deposits at the mouth of the Thelon River.

There are some areas that transition from deeper waters to shallow shoals. These are areas that can cause problems as the pressure waves developed under the ice from the travelling loaded vehicles cannot be dissipated as the water depth decreases. Relocation of the route to land or deeper waters is often required in these instances. Appendix C shows the winter road lake profiles indicating the ice cover and overall lake depth.

Pressure ridges in the ice are also areas to be avoided. The connection to the port across the Thelon River and Baker Lake both present issues. Figure 2.1-2 shows the location of this information.

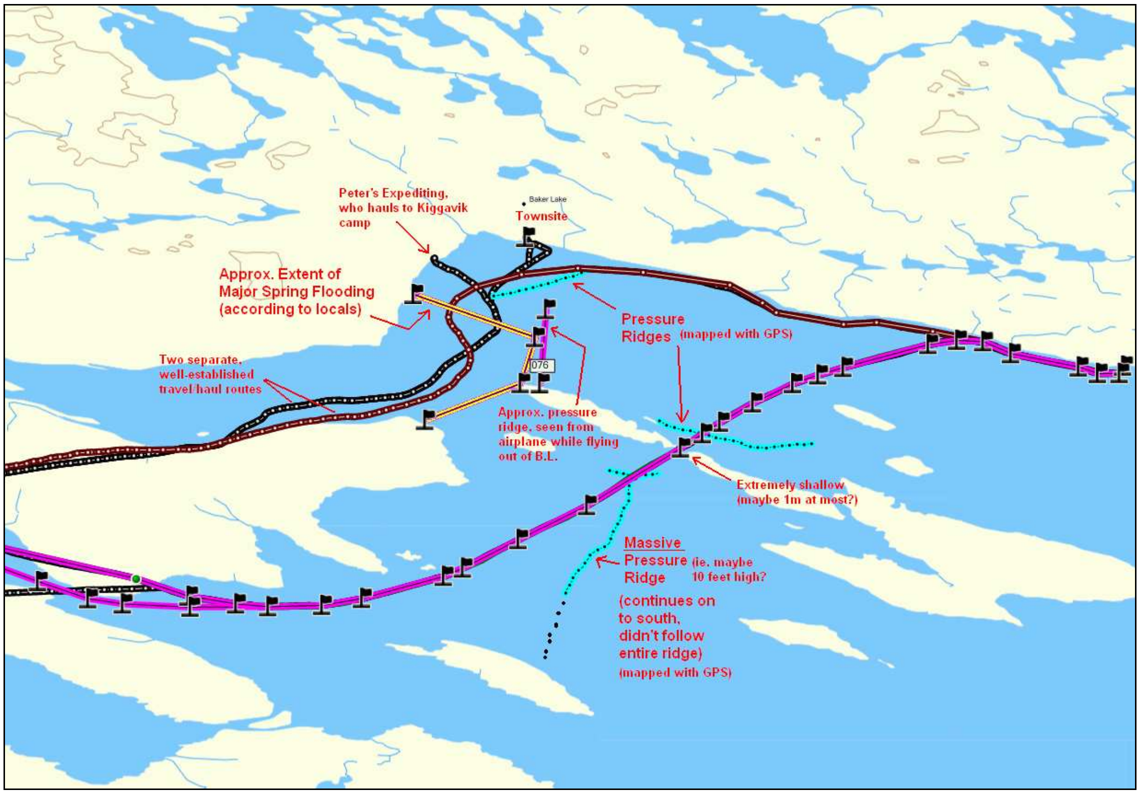

Figure 2.1-2: Ice thickness profiling tracks and ice condition observations, April 2009)

EBA's route recommendations are summarized in Table 2.1-2. The final route has not yet been chosen as additional information still needs to be gathered and evaluated. Some changes may include the termination of the winter road at Siamese lake where it can connect to a future road used to connect the water supply to the mine site.

TABLE 2.1-2: REVIEW OF WINTER ROAD ROUTES SURVEYED WITH GPR APRIL 2009	
Ice Crossing	**Comments (Reference Appendix C)**
Siamese Lake	- water depth of 5 to 6 m -a shoal exists near km 8 that could cause problems -Recommendation: use alternate route
20 km Lake	- deep with good bottom profile -Recommendation: good route; check ice thickness
Long Lake	-there are two major shoals (km 35.5 and km 37.5) that could be problematic; narrows at km36 may cause damage to ice from vehicle dynamic waves -Recommendation: requires more field investigation; may have to reduce vehicle speeds
North Audra Lake	-potential shoal at km43 -Recommendation: good route; check ice thickness
South Audra Lake	- shallow lake (2-3 m) where ice could freeze to bottom -Recommendation: good route;
Unnamed Lakes	-Four small (<1 km long) lakes that are shallow (less than 3 m) -Recommendation: good route; check ice thickness
Qinguq Bay—Option 2	-shallow lake (3-4 m deep) with potential for ground-fast ice -Recommendation: use this route over Qinguq Bay
Qinguq Bay—Option 2 Alternate	-shallow lake (3-4 m deep) with potential for ground-fast ice; would avoid the channel connecting the two lakes -Recommendation: use solid route
Qinguq Bay—Option 1	- less than 2.5 km long; up to 5 m deep; about ½ is potentially groundfast ice -Recommendation: use solid route
Baker Lake Option 2	-shallow between km90 and km101; depends (>8 m) from km120 to km110; -Small pressure ridge observed at km102 -Large pressure ridge (3 m high) observed at km 100 -Recommendation: requires more site field observations
Baker Lake Option 1	-overlaps with historical haul routes; -shallow between km 287 and 293; deep from km 293 to km 305; -pressure ridge observed near km 294 to 296; -km 292 to 293 overlaps with local observations of major spring flooding -Recommendation: requires more field observations

2.1.7 Potential Water Requirements and Water Availability

In case of on-land road and portages, water will be extracted from lakes along the road routing and placed on ice capped snow-covered frozen soil. The DFO clearly outlines in its

Protocol the amount of water which can be taken from a lake located in Northern Canada during one ice covered season (see Section 2.1.5.3). The required water quantity to be placed on the compacted snow along the road depends on expected traffic loads and density. Adding 10 cm of water on top of the snow increases the allowable contact pressure by a factor of 4-5, depending on the method of snow stabilization (degree of compaction).

TABLE 2.1-3: ESTIMATED LAKE WATER VOLUMES

Name of Lake	Water Volume [m^3]
Siamese Lake	105,000,000
"20 km Lake"	30,000,000
Long Lake	10,000,000
Audra Lake	265,000,000
Qinguq Lake	15,000,000

Assuming a road width of 10 m and that 50% of the winter road will be routed over land, the total quantity of water required with an ice cup of 10 cm amounts to approximately 50,000 m^3. Assuming further, that water is being wasted due to spillage and overwatering of about 50%, the potential water requirement amounts to 75,000 m^3.

Table 2.1-3 shows that any one of the five lakes has a sufficiently large water quantity to meet the requirements of road construction (maximum 10% of lake volumes).

2.1.8 Operating Window

The rate of ice growth on a lake surface in winter and how long it is sustained into spring is controlled by the "Winter Freezing Index" (WFI). The freezing index is a progressive summation of the mean daily air temperature below 0°C for each day of the month as the winter season progresses. At the end of winter the freezing indices for each month are summed to determine the total for the year. A day with a mean daily temperature of -20C° would contribute 20 to the air freezing index for the month. Hayley and Proskin (2008) showed that there is a reasonable correlation between the winter air freezing index and available operating window for the Tibbitt to Contwoyto Winter road that is constructed each year from near Yellowknife northeast to Lac de Gras. A typical winter season for Yellowknife air freezing conditions produces a road operating window of 75 days with about 15% of the time restricted to less than full loads. The WFI for Yellowknife and Baker Lake are compared in Figures 2.1-3 and 2.1-4. Figure 2.1-3 shows the WFI each winter month based on currently available Canadian Climate Normals (1970-2000) whereas Figure 2.1-4 shows how the Index accumulates as the winter progresses. The total WFI is 49% greater at Baker Lake than at Yellowknife.

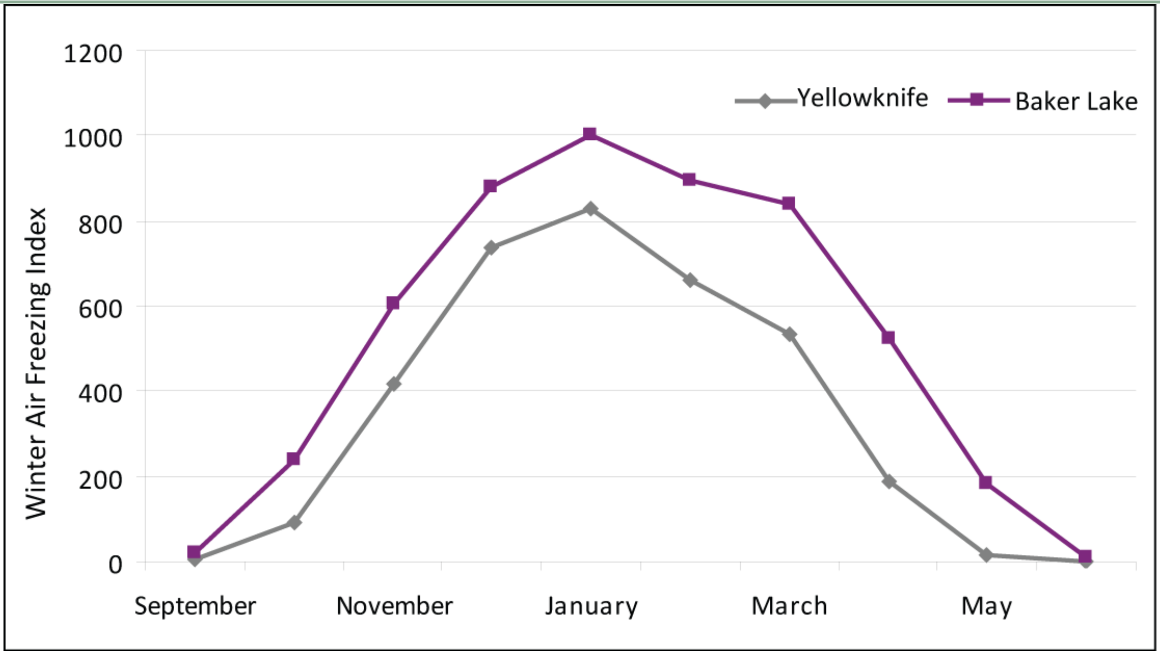

Figure 2.1-3: Comparative Winter Freezing Indices

A direct comparison of the operating periods for the two roads suggests that the Baker Lake Road can open two weeks earlier and close 4 to 5 weeks later than the TCWR. A comparison of the freezing indices also shows that the ice should be able to support light construction equipment for snow removal by early December, providing a 4 to 5 week period for road opening each winter. It should be noted that the operating period will be shortened during the season during inoperable driving conditions. These events include blizzards. Minimal information is available on the duration of blizzards in this area. Weather data stations, over time, give a good indication of the extent of blizzard durations. . It should be noted that for this road, with approximately 50% of the route over land, that the controlling criterion for the road closure will be related to the land, rather than the lakes. The road, constructed over the tundra, will deteriorate at a greater rate than the lakes.

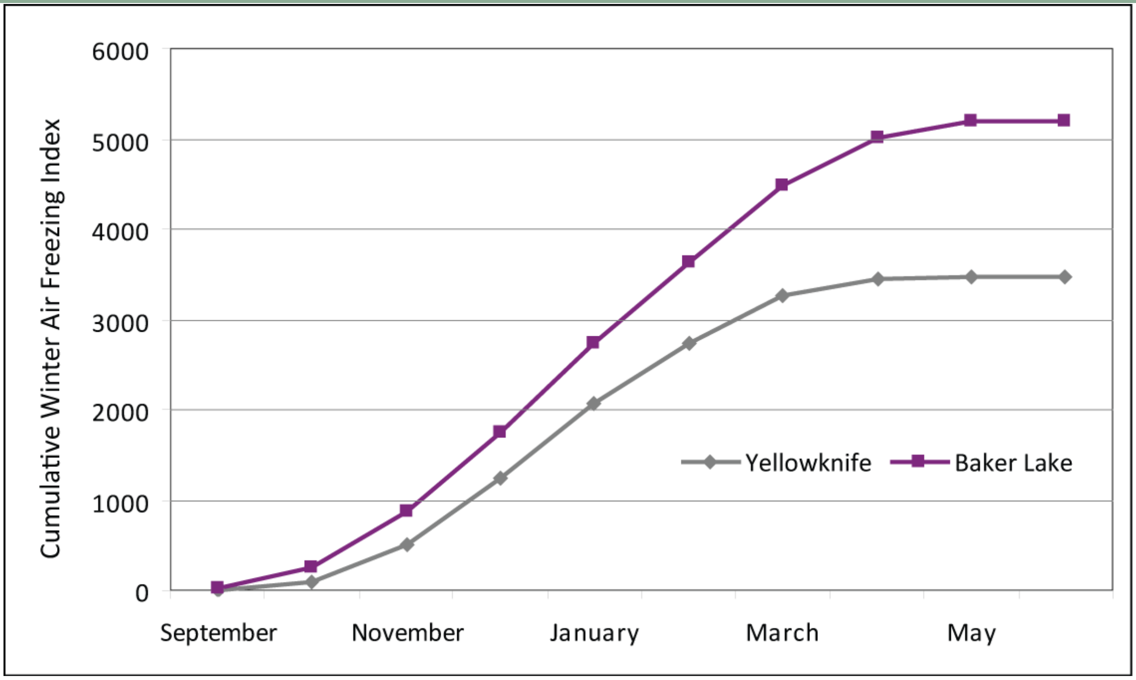

Figure 2.1-4: Comparative Cumulative Winter Air Freezing Indices

The estimated operating period is about 110 days compared to 75 days for the TCWR, however this estimate is based on Canadian Climate Normals that are known to not represent current climatic conditions. An analysis of the TCWR operating precedents has shown about a 17% degradation in WFI over the past 20 years. This change has been attributed to climate warming. For winter road planning purposes, an operating period of 90 days is recommended.

TABLE 2.1-4 COMPARISON OF BAKER LAKE AND YELLOWKNIFE CLIMATIC NORMALS (1971-2000) DATA

Parameter	Baker Lake (YBK)	Yellowknife (YZF)
Mean Annual Air Temperature (°C)	-11.8	-4.6
End of month average snow cover (cm)		
November	30	21
December	38	27
January	42	33
February	47	38
March	54	37
April	53	6

Table 2.1-4 compares of the end-of-month snow cover for Baker Lake and Yellowknife to assess the amount of snow that could be available for constructing compacted snow/ice surfaces. In general Baker Lake has considerably more snow cover than Yellowknife.

However, distribution of snow cover in the Baker Lake region is known to be highly variable and depends on surface topography, wind direction, and the presence of vegetation/surface features. Topographic highs tends to be wind swept and bare of snow while lowland areas and areas on lee side of surface features tend to collect snow in drifts. Observations during the end of winter field trip in 2010 suggest that early snow cover will not be an issue with road construction but some areas will need snow drift management practices such as snow fences to minimize drift formation.

2.1.9 Operations and Logistics

The Tibbitt to Contwoyto Winter Road has been operated continuously since the early 1980's and has an extensive experience base associated with highway legal haul vehicles bringing in thousands of tonnes of fuel and supplies each year to three operating mines located along the 350 km long road. The TCWR extends from the Ingraham Trail and when it crosses the tree line and enters the barren lands its terrain conditions are not unlike those along the Kiggavik Winter Road alignment. Table 2.1-5 compares the operating data for the TCWR (2003 to 2009) with Areva's functional requirements from the project description for Kiggavik. It is clear that the TCWR operating requirements and Kiggavik road functional requirements are similar. The TCWR experience base is an effective tool in estimating operating parameters for the Kiggavik winter road.

TABLE 2.1-5: COMPARISON OF WINTER ROAD FUNCTION REQUIREMENTS/OPERATING PARAMETERS

Parameter	Kiggavik	TCWR
Number of loads per year	3920	6862 (4847 to 10,922)
Supplies/Fuel Moved (metric tons)	140,500	222,400 (173,000 to 330,000)
Number of loads per day	43	120 (84 to 174)
Operating window in days	90 (80-110)	75 (50 to90)
Average metric tons per load	32 for dry/43 for fuel	32 (26 to 38)

The TCWR Joint Venture has found it necessary to dispatch 84 to 174 loads per day because of its shorter operating window and longer route. This requires a substantial fleet of trucks and drivers. The initial estimate of 43 truck loads per day is well within the experience range for the TCWR. This means that a smaller fleet of trucks and drivers would be necessary to accommodate the lower dispatch numbers. Based on an average speed of 25 km/h for a loaded vehicle, the travel time to site is approximately 4.5 hours; with a slightly faster return time of 3.5 hours, a round trip would take approximately 12 hours (assuming loading and unloading can take place in 4 hours). Assuming a 24 hour dispatch operation with new drivers every 12 hours, a fleet of 24 trucks operating around the clock could make around 48 trips in a 24 hour period. This assumes that there is no downtime due to weather delays, equipment breakdowns, or delays due to poor traffic conditions along the winter road.

2.1.9.1 Construction Schedule

We can estimate the potential range of milestone dates through inferences from the operating experience obtained from the TCWR.

- Initial profiling and pioneering of the ice crossings ………. early December
- Achieve ice thickness for plough trucks and clear full road width ………………………………… mid December
- Achieve ice thickness for deploying partially loaded B-trains and Super B trains ……………………………… early January
- Achieve ice thickness for 100% loaded B-trains and Super B trains ……………………………………….. late January
- Achieve maximum ice thickness ………………………… early February
- Suspend ice crossing operations …………………………. End April

2.1.9.2 Maintenance

Ice crossings, ice growth, and ice quality can be encouraged to extend the operating window for the ice crossings. Such measures include the following:

- Selecting a route that avoids locations that would adversely affect ice conditions, such as river inlets/outlets, pressure ridges (which tend to re-occur at the same locations);
- Clearing snow from the route as early as possible to promote natural growth;
- Flooding areas that have slow growing ice;
- Building alternate lanes that can act as an express lane for empty vehicles returning to Baker Lake or a back up lane as a contingency if a particular location is prone to ice blowout;
- Monitoring and repairing/maintaining ice crossings throughout operations;
- Implementing operating rules to reduce the potential for damage to the ice crossings caused by excessive speed or closely spaced vehicles.

Winter road surfaces should be kept as clean as possible to reflect sunlight, particularly at portages. The snow ice surface is maintained by dragging excess snow from the ice cover towards the portage, packing it down and watering the snow layer. This procedure should be repeated as necessary.

With warmer temperatures approaching in the spring, melting of the ice cover generally is initiated along the lake shore-the location of the portages (also called moats). Clean snow should be stored along the road and thinly spread on the road surface with the advancement of the spring season. This thin layer of snow should not be watered down.

2.1.9.3 Cost Estimate

Through a review of its project files, EBA has provided some general costs for the construction and operations of both over-ice crossings and over-land crossings. The costs include equipment and labour force requirements but do not include design and engineering effort and the suite of related work nor do they include planning and regulatory approval. The initial opening of a long winter road is equipment and labour force intensive. Remoteness of the route and lack of nearby infrastructure can have a substantial effect on the cost. Operational costs will also depend on terrain, water crossings and environmental constraints. These costs give an indication of a typical cost of a winter road. The costs in Table 2.1-6 do not reflect the discussion concerning progressive upgrading of certain portages over time by construction of a permanent subbase of granular material over locations with rough surface microtopography. These locations can only be determined following one or more years of opening, operation and road maintenance. Past projects have found that small operations to fill in certain areas each year are cost effective in that they will return operating efficiencies.

TABLE 2.1-6: CONSTRUCTION AND MAINTENANCE COSTS FOR WINTER ROADS

Crossing Type	Construction and Maintenance Cost for One Season ($/km)
Compacted snow road	$35,000 per km
Compacted snow road with an ice cap	$25,000 to 41,000 per km
Floating ice road with overland portages	$22,000 per km

2.1.10 Gaps and Recommendations for Further Work

Two alternative routes have been identified with sufficient confidence for feasibility study purposes. The northern route requires an ice bridge over the Thelon River. The suggested location for the crossing was chosen during the June 2010 field visit and confirmed by discussion on site with three Inuit elders on site that their past experience supports the chosen location. An ice bridge crossing is certainly feasible and has ample precedent. It does add complexity to the road opening, however and will require additional information in order to develop a design and construction operating procedure. That information should include the following.

- Observations of river breakup at the chosen location.
- Early season ice thickness measurements,
- Current measurements under the ice in winter.

This information can be collected during the winter of 2010-11 working from Baker Lake with a snowmobile.

There are routing alternatives along both routes but particularly the southern, preferred route. Those alternatives should be selected based on on-the-ground examination of topographic features that was not possible in June 2010 due too thick remaining snow cover. That field work needs to be carried out in summer before snow returns to the area and should include personnel from both Nuna and EBA.

3.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

Yours truly,
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PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.

Signature ______

Date OCT. 5, 2010

PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

APPENDIX A

APPENDIX A REFERENCE DRAWINGS AND SUPPORTING DOCUMENTATION

List of Data in Appendix A:

A1 – LiDAR Survey Report

A2 – Baker Lake Sonar Report

A3 – Mill Site and Sik Sik Lake Geophysics Survey

A4 – Andrew Lake Dyke Geophysics Survey

A5 – Thelon Crossing – Geophysics Survey

A6 – Winter Road Geophysics Survey

A7 – North Port Site Bathymetric Data

A8 – 2009 Mill Site Borehole Logs

A9 – Summary of Activities Thelon ice Observations

A10 – Project Photo Log

Note:

Appendix A is a large compilation of reference drawings and documents that contains information common to all of the other Reports as well. To avoid unnecessary duplication, it has not been attached to each Report, but has been submitted as a separate document.

APPENDIX

APPENDIX C WINTER ROAD LAKE PROFILES